

## **LISTING OF THE CLAIMS**

Claims 1-33 are pending. Please amend claims 1, 11-13, 18-19, 22-28 and 30. No claims have been canceled, added, or withdrawn.

The following listing of claims replaces all prior versions and listings of claims in the application.

1. (Currently amended) A method implemented at least in part by a computing device for representing sequential motion patterns, the method comprising:

converting video frames into a sequence of energy redistribution (“ER”) measurements; and

applying one or more motion filters to the ER measurements to generate a number of temporal sequences of motion patterns, the motion patterns being in a spatio-temporal data format, the number being a function of how many motion filters were applied to the ER measurements.

2. (Original) A method as recited in claim 1, wherein each motion filter of the one or more motion filters is a weighting matrix of values designed to identify a particular type of motion.

3. (Original) A method as recited in claim 1, wherein converting further comprises determining a change in energy distribution between multiple ones of the video frames via respective motion vector fields (MVF), the video frames being within a sliding window of video frames.

4. (Original) A method as recited in claim 1, wherein converting further comprises configuring a width and/or frame frequency sampling parameter associated with the sliding window to adjust computational complexity and/or performance of the method.

5. (Original) A method as recited in claim 1, wherein energy at block (x, y) of a frame of the video sequence is denoted by  $E_{x,y}$ , and wherein converting further comprises determining a change in energy distribution  $E'$  between the block (x, y) and block (i, j) in a previous frame of the video sequence as a function of:

$$E'_{x,y} = \frac{\sum_{i,j} (\text{overlap} S_{i,j,x,y} \times E_{i,j})}{W_b^2}, \quad i, j \in [1, W_b]; \text{ and}$$

wherein  $\text{overlap } S_{i,j,x,y}$  denotes an overlap portion of a rectangular region corresponding to block (i, j) and block (x, y), and  $W_b$  represents block size.

6. (Original) A method as recited in claim 5, wherein converting further comprises, if a block is not in a frame boundary, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

7. (Original) A method as recited in claim 5, wherein each motion filter is a respective weighting matrix of values, elements of each weighting matrix being denoted as  $w_{i,j}$ , and wherein applying further comprises calculating an ER measurement from respective ones of the video frames such that resulting temporal energy responses  $E_R$  are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i, j \in [1, W_b]; \text{ and}$$

wherein,  $E_{i,j}$  denotes the energy distributed in each block  $(i,j)$ , and  $W_b$  represents block size.

**8.** (Original) A method as recited in claim 1, further comprising:

for each motion filter, identifying a respective mean energy value of a temporal sequence associated with the motion filter; and

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing ER responses to each of the motion filters and original input and difference temporal sequences.

**9.** (Original) A method as recited in claim 8, further comprising analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

**10.** (Original) A method as recited in claim 9, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

**11.** (Currently amended) A computer-readable medium encoded with a computer program including computer-executable instructions comprising ~~computer program instructions executable by a processor~~ for performing operations ~~as recited in~~ of the method of claim 1.

12. (Currently amended) A computing device comprising ~~a processor coupled to a memory, the memory comprising computer program instructions executable by the processor~~ a computer-readable medium encoded with a computer program including computer-executable instructions for performing operations as recited in the method of claim 1.

13. (Currently amended) A computer-readable medium encoded with a computer program including computer-executable instructions ~~comprising computer program instructions~~ for representing sequential motion patterns, the computer-program instructions being executable by a processor, ~~the computer-program instructions comprising instructions~~ for:

generating one or more motion filters according to respective ones of primary motions in a video sequence, each of the motion filters being responsive to a particular one dominant motion of the primary motions;

calculating energy redistribution measurements between respective frames of the video sequence, the respective frames being determined by a sliding window of video frames of the video sequence;

converting the energy redistribution measurements into temporal sequences showing distinct motion patterns, each temporal sequence being generated responsive to application of a particular one of the motion filters to the energy redistribution measurements; and

wherein the temporal sequences represent high-level spatio-temporal motion patterns of the video sequence.

**14.** (Original) A computer-readable medium as recited in claim 13, wherein each motion filter is a weighting matrix of values designed to identify a particular type of motion.

**15.** (Original) A computer-readable medium as recited in claim 13, wherein energy at block (x, y) of a frame of the video sequence is denoted by  $E_{x,y}$ , and wherein calculating further comprises determining a change in energy distribution  $E'$  between the block (x, y) and block (i, j) in a previous frame of the video sequence as a function of:

$$E'_{x,y} = \frac{\sum_{i,j} (\text{overlap}S_{i,j,x,y} \times E_{i,j})}{W_b^2}, \quad i, j \in [1, W_b]; \text{ and}$$

wherein  $\text{overlap}S_{i,j,x,y}$  represents an overlap portion of a rectangular region corresponding to block (i, j) and block (x, y), and  $W_b$  represents block size.

**16.** (Original) A computer-readable medium as recited in claim 13, wherein converting further comprises:

determining that a block is not in a frame boundary associated with frames of the video sequence; and

responsive to the determining, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

**17.** (Original) A computer-readable medium as recited in claim 13, wherein each motion filter is a respective weighting matrix of values, elements of each weighting matrix being denoted as  $w_{i,j}$ , and wherein applying further comprises calculating an ER measurement from respective ones of the video frames such that resulting temporal energy responses  $E_R$  are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i, j \in [1, W_b]; \text{ and}$$

wherein,  $E_{i,j}$  denotes the energy distributed in each block  $(i,j)$ , and  $W_b$  represents block size.

**18.** (Currently amended) A computer-readable medium as recited in claim 13, wherein the ~~computer program~~ computer-executable instructions further comprise instructions for:

identifying, for each motion filter, a respective mean energy value of a sequence of the temporal sequences associated with the motion filter;

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing energy redistribution responses to each of the motion filters and original input and difference temporal sequences.

**19.** (Currently amended) A computer-readable medium as recited in claim 18, wherein the ~~computer program~~ computer-executable instructions further comprise instructions for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

**20.** (Original) A computer-readable medium as recited in claim 19, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

**21.** (Original) A computing device comprising a processor coupled to a computer-program medium as recited in claim 13.

**22.** (Currently amended) A computing device comprising:

a processor; and

to a memory, the memory comprising computer program instructions executable by the processor for a computer-readable medium coupled to the processor, the computer-readable medium being encoded with at least one computer program including computer-executable instructions that when executed by the processor perform operations for:

deriving motion vector fields (MVFs) between frames of a video sequence as a function of a sliding window comprising a configurable number of the frames, each MVF representing an energy distribution between a particular block in a first frame of the frames and a different block in a second frame of the frames that is adjacent to the first frame;

modifying content of the sliding window to include a new frame of the frames;

responsive to modifying the content, updating, the represented energy distributions for each block, the updating being based on an overlap portion of the block and a previous block of a previous frame of the frames; and

motion filtering the energy distributions to sequentially represent one or more motion types presented by the video sequence over time, the one or more motion types identifying one or more sequential motion patterns of the video sequence.

**23.** (Currently amended) A computing device as recited in claim 22, wherein the ~~computer program~~ computer-executable instructions for updating further comprise instructions for:

representing energy at block (x, y) of the current frame as  $E_{x,y}$ ; and

wherein updating further comprises determining a change in energy distribution  $E'$  between the block (x, y) and block (i, j) in the previous frame as a function of:

$$E'_{x,y} = \frac{\sum_{i,j} (\text{overlap} S_{i,j,x,y} \times E_{i,j})}{W_b^2}, \quad i, j \in [1, W_b]; \text{ and}$$

wherein  $\text{overlap} S_{i,j,x,y}$  represents the overlap portion, the overlap portion being a rectangular region corresponding to block (i, j) and block (x, y),  $W_b$  representing block size.



24. (Currently amended) A computing device as recited in claim 22, wherein the ~~computer-program~~ computer-executable instructions for deriving and/or updating further comprise instructions for:

determining that a block of the frames is not in a frame boundary; and

responsive to the determining, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

25. (Currently amended) A computing device as recited in claim 22, wherein the ~~computer-program~~ computer-executable instructions for motion filtering further comprise instructions for applying a weighting matrix of values designed to identify a particular type of motion to the energy redistributions.

26. (Currently amended) A computing device as recited in claim 22, wherein the ~~computer-program~~ computer-executable instructions for motion filtering further comprises instructions for applying a motion filter designed to identify a particular type of motion to the energy redistributions, each motion filter being a respective weighting matrix of values, elements of each weighting matrix being denoted as  $w_{i,i}$ ; the applying comprising calculating a respective energy redistribution measurement from respective ones of the frames such that resulting temporal energy responses  $E_R$  are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i, j \in [1, W_b]; \text{ and}$$

wherein,  $E_{i,j}$  denotes the energy distributed in each block  $(i,j)$ , and  $W_b$  represents block size.

**27.** (Currently amended) A computing device as recited in claim 22, wherein the ~~computer program~~ computer-executable instructions for motion filtering further comprise instructions for:

identifying, for each motion filter of one or more motion filters, a respective mean energy value of a sequence of the temporal sequences associated with the motion filter;

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing energy redistribution responses to each of the motion filters and original input and difference temporal sequences.

**28.** (Currently amended) A computing device as recited in claim 27, wherein the ~~computer program~~ computer-executable instructions further comprise instructions for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

**29.** (Original) A computing device as recited in claim 28, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

**30.** (Currently amended) A computing device for representing sequential motion patterns, the computing device comprising:

means for converting video frames into a sequence of energy redistribution (“ER”) measurements; and

means for applying one or more motion filters to the ER measurements to generate a number of temporal sequences of motion patterns, the motion patterns being in a spatio-temporal data format, the number being a function of how many motion filters were applied to the ER measurements.

**31.** (Original) A computing device as recited in claim 30, wherein the means for converting further comprises means for determining a change in energy distribution between multiple ones of the video frames via respective motion vector fields (MVFs).

**32.** (Original) A computing device as recited in claim 30, further comprising:  
for each motion filter, means for identifying a respective mean energy value of a temporal sequence associated with the motion filter; and

means for combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing ER responses to each of the motion filters and original input and difference temporal sequences.

**33.** (Original) A computing device as recited in claim 30, further comprising means for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.